

Information Technology ***for Engineering & Manufacturing***

The Future of Simulation

This presentation is a forecast for simulation over the next five years. It also discusses the limitations to the spread of simulation. The author warns that his predictions may be mere speculation.

Presented by Jerry Banks

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The Future of Simulation

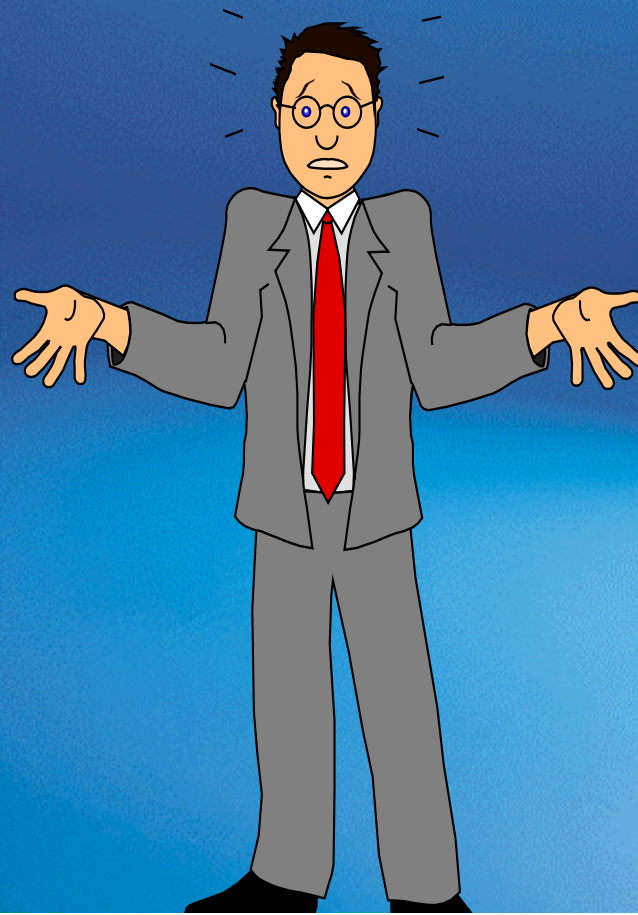
Jerry Banks
AutoSimulations, Inc.

Business Week

- We are in the midst of change
 - Electronic commerce
 - The internet
 - B2B
 - B2C
 - B2B2C
 - SCM
- What is the role of simulation?

Introductory Tutorial at WSC

- What do you see happening in simulation over the next five years?



WSC 1997 and 1998

- Seven areas in 1997
- Five areas in 1998
 - Internet applications
 - ERP applications
 - Embedded simulation
 - Optimization
 - Object-oriented simulation

WSC 1997 and 1998

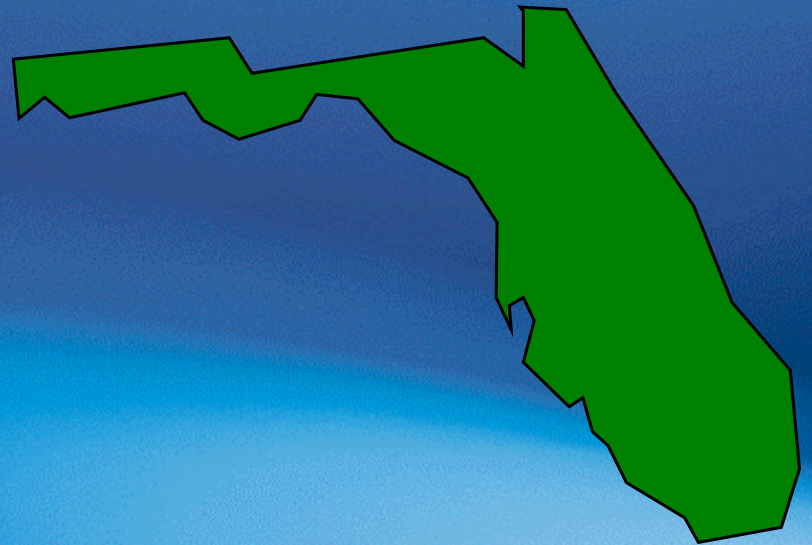
- Only two areas in 1997 were in the 1998 list
- $2/7 = 0.29$
- $0.29^5 = 0.002$
- That is, believe me with an accuracy of 0.2%

WSC 1999

- Mixed it up
 - Consultant
 - Academic
 - Two corporate simulationists
 - Two software vendors
- Pull rather than push
- “What does industry need from simulation vendors in Y2k and after?”

Incidentally

- WSC 2000
 - Wyndham Palace Resort & Spa
 - Orlando, FL USA
 - December 10-13, 2000
 - www.wintersim.org



Mini-track

- IMS MISSION
- High Fidelity Simulation
- Model Composability
- Panel Session

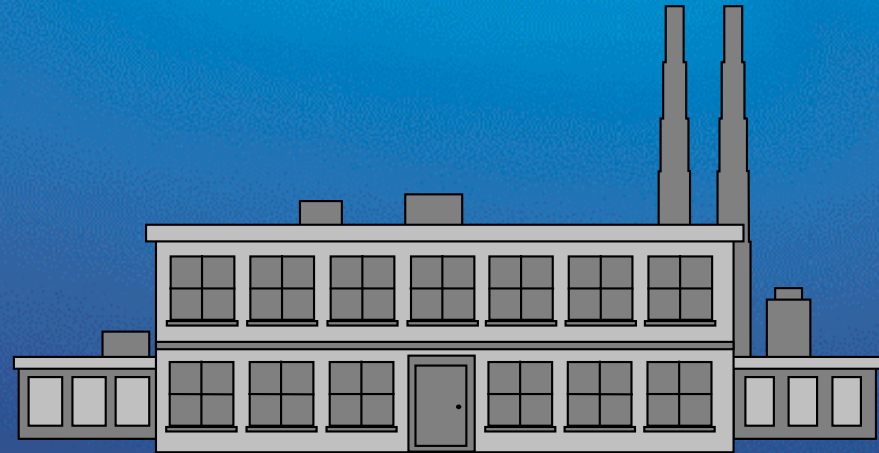
IMS MISSION

- Intelligent Manufacturing Systems Modeling and Simulation Environments for Design, Planning and Operation of Globally Distributed Enterprises
- Global effort
 - US
 - Japan
 - Europe
 - Australia



High Fidelity Simulation

- Virtuality
 - Virtual machine
 - Virtual factory
 - Virtual warehouse
- Why is it important?
 - \$1,000,000 centerless grinder
 - Or, a \$1,000,000 centerless grinder modeled in the computer



Model Composability

- HLA, reusability, federated modeling, object-oriented modeling, distributed simulation, component-based software...

Panel Session

- Very well attended in the past
- WSC 2000
 - The viewpoint of consultants



Why Simulation?

- One of the top 3 technologies
- Simulation is no longer the “technique of last resort”
- It is an indispensable problem-solving methodology

Why simulation?

- Real systems are random
 - Demands
 - Time to failure
 - etc.
- Random systems cannot be easily analyzed with static modeling tools

Why simulation?

- Modern manufacturing system
 - Investment costs are high
 - Tolerance for error is low
- Simulation helps to
 - Hold costs down
 - Decrease errors

Data Exchange Standards

- Lowest level
 - CAD to simulation software
 - Most software can import a CAD file
 - Three components
 - Movement systems
 - Dynamic entities
 - Static background...the CAD drawing

Data Exchange Standards

- Material handling system
 - Standardized format
 - Conveyors
 - Pathways
 - Vehicles
 - etc.
 - Collaborative modeling would be possible

EAI and SDX

- Engineering Animation Incorporated
 - Simulation interface
 - SDX
 - Simulation Data Exchange
- Several simulation firms can import SDX files
- Works best with Material Handling System
- 25% to 75% can be automatically defined using SDX

XML

- Extensible Markup Language
- Worldwide Web Consortium (W3C)
- Rules, guidelines, conventions for designing text formats for data
 - Such that files are
 - Easy to generate and read
 - Unambiguous
 - Extensible

XML

- Large and growing community
- Many tools do not yet exist
- Coordinated by NIST
- Eventually, some group will want to develop XML standards for Mfg/MH

The Web

- Several people helped me to prepare this presentation
 - Chuck McLean of NIST
 - Al Jones of NIST
 - John Carson of ASI
 - Brian Stanley of ASI
 - Dennis Pegden of Systems Modeling

Al Jones answered

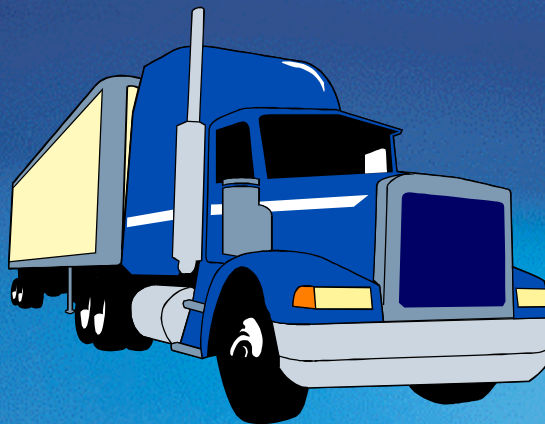
- “The web”
- Why is it so important?
- Two reasons
 - Big changes in logistics
 - Java

Big changes in logistics systems

- Order a computer from Alpha Computer Company
 - Computer arrives 3 days later in an Alpha box
 - Delivered by Beta Parcel Service
 - Did Alpha build that computer?
 - Maybe not
 - Beta may have built it and delivered it

Big changes in logistics systems

- Big changes need to be simulated
- Lots of logistics models



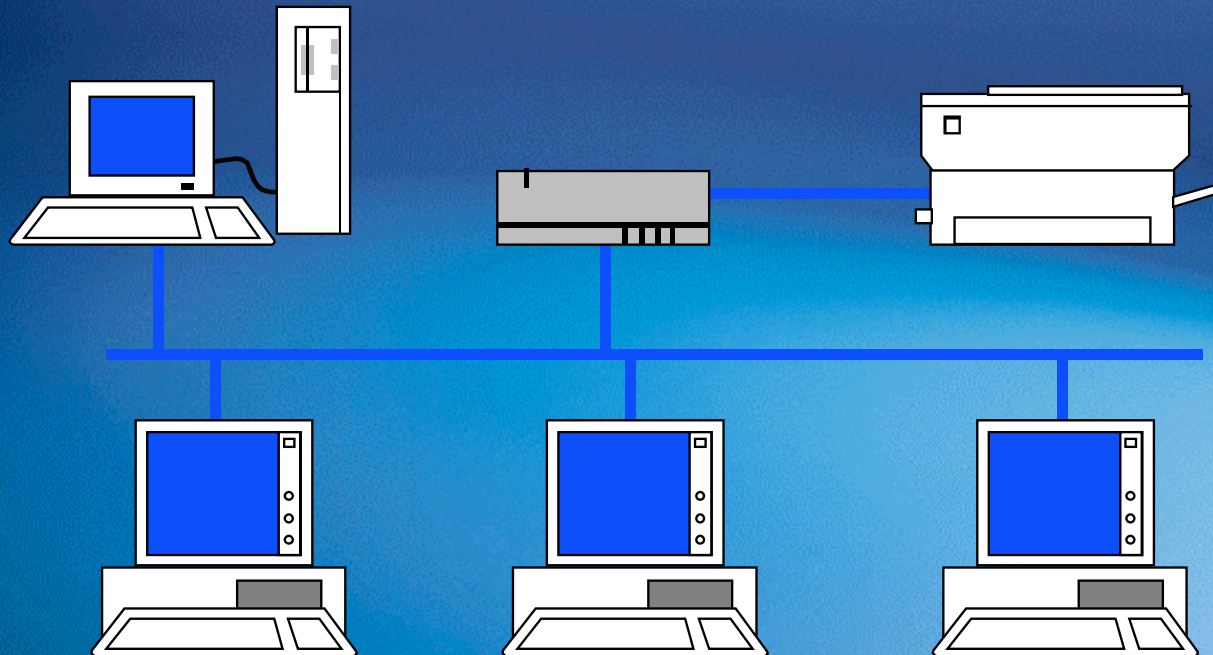
Java



- Maybe bigger than logistics on the web
- Delivery of modeling capability via the web
- Interface at the client site
- Models run on a server
 - Latest version of the model
- Java interface and animator
- Java is too slow to be the simulation engine

Distributed Computing

- Replications made on many computers within a network
- We do this now



Rent Software?

- Clients could pay for use of software via the web on a time basis



Old Paradigm vs New Paradigm

- Purpose built models vs prebuilt objects
- Hierarchical models
 - Different levels of fidelity
 - Low resolution to high resolution
 - Constructed by placing pre-built objects into the model
 - Higher level models aggregate information from lower level models
 - To be able to answer questions faster

Old Paradigm vs New Paradigm

- The firm with more prebuilt objects will be able to answer questions faster, or
- The firm with more prebuilt objects will have more out-of-date models

Module Libraries

- Module libraries stored in a neutral file format
- Example would be a robot manufacturer who provides a module for a specific robot
- Challenge is to come up with a file format that will be acceptable to many software vendors

Collaboration

- Larger models require joint effort in model building and maintenance
- Modelers dispersed in time and space can work together via the internet

Model Interchange

- Generic parts make up a PC
 - Many sources for motherboard, modem, ...
 - The components work well together
 - Interoperability
 - Interoperable simulation models
 - Material handling simulation from Vendor X
 - Logistics simulation from Vendor Y
 - Front office simulation from Vendor Z
 - etc.

Model Interchange

- Big problems in making that happen
 - Need interface specifications
 - Need model synchronization

Distributed Manufacturing Simulation

- Instead of screen saver coming on, computer could begin processing a simulation
- Over the internet

Distributed Manufacturing Simulation

- Currently, we distribute replications over a local network
- If 10 replications are needed, each requiring 4 hours, we can distribute that task to five computers, each performing two replications over night
- The host computer controls the others and collects the output

Supply Chains

- MHRC at Georgia Tech from 1983 to 1992
- Then 'logistics' became the buzz word
- logistics = supply chains
- The Logistics Institute
- Many companies going through big changes

Supply Chains

- “Simulation is the friend of change”
 - Dennis Pegden
- Simulation models can be used to understand these new processes
- Simulation models are used to study the entire supply chain from suppliers to final customer delivery
 - Complex systems with many interacting and random elements

Spread of Simulation

- Steady progression of simulation users
- But, not growth by leaps-and-bounds



A paradox

- Simulation is a widely accepted tool for predicting performance of complex systems
- Simulation is used in only a small fraction of the cases where it can have a significant impact

Competition

- “My biggest competitor is the decision not to use simulation”
 - Brian Stanley

Spread of Simulation

- Simulation is both an art and a science
 - Bob Shannon said it 25 years ago
 - Still true today
- My first PC in 1981
 - Wordstar
 - Open a book and start typing
- Simulation model building requires a system perspective and understanding

Spread of Simulation

- Complex problems require complex solutions
 - Averill Law
- Reducing the complexity is a great challenge

Spread of Simulation

- Reducing complexity
 - Not to be achieved at the expense of flexibility
 - Simulators, templates, palettes, etc.
 - Good, but must be robust

Spread of Simulation

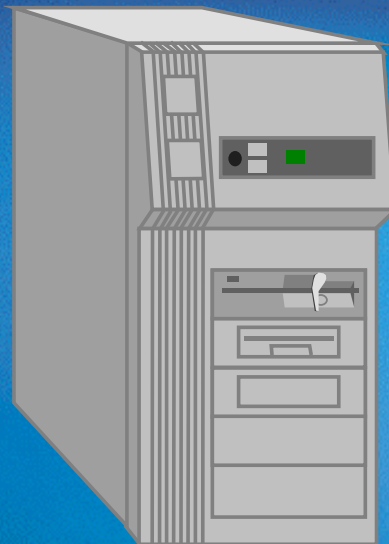
- Simulation takes time and money
 - ‘No wine will be sold before its time’
 - Simulation takes time
 - Cases where decision makers can’t wait for the simulation results
 - Bad for the simulation business
 - “Good for the simulation business”
 - John Carson

Spread of Simulation

- Interpreting simulation results can be difficult
 - Especially true for those whose statistical competence is slow
 - Use an output analyzer

Spread of Simulation

- Simulation is slow
 - CPU speed going up
 - Still there are users complaining about the time to perform a replication
 - As models get bigger



Spread of Simulation

- Visualization is a great benefit
- Simulation must look as good as Saturday morning cartoons
- Enhance visualization
 - But, don't increase complexity of use

Invisibility

- Simulation software needs to become less visible!
- Already true in simulation-based scheduling
- Strength of current simulation software is not in the interface
 - It is in the ability to model randomness

Optimization

- Two years ago optimization was in its infancy
- Now, most of the software vendors have some optimization
- But, there are still problems

Optimization

- Major problem is the time that it takes
- Causes
 - Number of variables
 - Discrete
 - Continuous
 - Constraints on the solution space
 - Simple bound
 - Linear
 - Non-linear

Optimization

- Problems
 - Type of objective function
 - Linear
 - Quadratic
 - Nonlinear

Optimization

- Say that a simulation takes 10 minutes per replication and that we are doing five replications
- That's 50 minutes

Optimization

- Genetic algorithms
 - Work with function evaluations
 - 1000 would not be unreasonable
 - $10 \times 5 \times 1000 = 50,000$ minutes
 - More than one month
 - Unreasonable

Optimization

- Smart user can take short cuts
 - Eliminate experiments
- Little impact on outcome
- Use factorial experiments in a clever way
- Much research left to be done
- Lots of opportunities for Ph.D. dissertations

HLA

- Much has been said recently about High Level Architecture
 - To facilitate interoperability
 - To promote reuse of simulations

HLA

- Started in the simulation of combat
- Exported to the world of manufacturing and material handling
 - IMS MISSION
- Lots of acronyms
- First five pages had 19 acronyms

HLA

- In manufacturing and material handling
 - There has to be a data exchange format
 - This is an evolutionary process
 - Time flow and synchronization have to be worked out
 - Simulation software is inconsistent in it's internals
 - Schriber and Brunner
 - Tendency of vendors
 - “Stick to your knitting!”

Summary

- Letting the mind wander allows for many future possibilities
- But, my predictive abilities have not been that good in the past!